# Resuscitative cesarean delivery: when every second counts

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The incidence of maternal cardiac arrest is rising, paralleling the escalating maternal morbidity and mortality rates in the United States. Effective management of cardiac arrest in pregnancy requires timely initiation of a resuscitative cesarean delivery when indicated. Understanding the history, indications, maternal physiology, and surgical principles of resuscitative cesarean delivery is essential for all clinicians caring for pregnant patients. Resuscitative measures during maternal cardiac arrest have evolved through the centuries—beginning as a burial practice for both mother and baby, evolving further to attempt fetal salvage, and now, to maternal rescue. During this evolution, performing resuscitative cesarean delivery was most effective if initiated within 4 minutes of maternal cardiac arrest. This concept led to the term "4-minute rule" or the principle of initiating a resuscitative cesarean delivery within 4 minutes of arrest to optimize maternal and fetal outcomes. Furthermore, the terminology has also progressed. "Resuscitative cesarean delivery" is now preferred over "perimortem cesarean delivery," emphasizing the goal of maternal resuscitation rather than fetal salvage.

Successful maternal resuscitation may occur from resuscitative cesarean delivery due to relieving aortocaval compression by the gravid uterus, thus restoring venous return and cardiac output. Additional benefits include an autotransfusion effect from the uteroplacental circulation and improved oxygenation. Due to this aspect of maternal physiology, resuscitative cesarean delivery is indicated when maternal cardiac arrest occurs at 20 weeks' gestation or greater, or when the fundus is at the level of the umbilicus and should be considered immediately upon cardiac arrest in term patients or in those arriving pulseless from the prehospital setting.

Rapid bedside initiation of resuscitative cesarean delivery is critical; transporting the patient to the operating room causes harmful delays. Training multidisciplinary teams to perform resuscitative cesarean delivery at the site of arrest can improve adherence to the "4-minute rule" and survival rates. Surgical technique prioritizes speed and simplicity, favoring a vertical midline skin incision and a vertical uterine incision to minimize vascular injury and facilitate rapid uterine evacuation.

Postprocedure, recovery is optimized by proper wound management via broad-spectrum antibiotics and consideration of delayed wound closure, stabilization of uterine hemostasis, and careful application of critical care in the postpartum setting. In summary, resuscitative cesarean delivery is a critical, life-saving intervention during maternal cardiac arrest, providing physiological decompression, enhancing maternal resuscitation efforts, and improving neonatal outcomes. Resuscitative cesarean delivery substantially improves the chances of maternal return of spontaneous circulation and fetal survival in cases of maternal cardiac arrest. Given the persistent rise in maternal morbidity and mortality, increased awareness and readiness to perform resuscitative cesarean delivery using protocolized training and interdisciplinary coordination are imperative to improving maternal and perinatal outcomes in the modern healthcare landscape.

**Key words:** 4-minute rule, cardiac output, emergency delivery, maternal cardiac arrest, resuscitative cesarean delivery

## Introduction

Data from the National Inpatient Sample, the largest publicly available all-payer inpatient healthcare database in the United States, reveal a rising incidence in maternal cardiac arrest in the 21st century, increasing from 1 in 12,000 to 1 in 9000 cardiac arrests per 100,000 delivery admissions between 1998 to 2011 and 2017 to 2019, respectively.[1,2] This trend parallels the continuing rise in pregnancy-related morbidity and mortality in the United States.[3] As such, a clear understanding of the indications, surgical techniques, and postoperative management of cesarean delivery during maternal cardiac arrest is essential for clinicians involved in the care of pregnant patients.

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Comprehensive management of cardiac arrest during pregnancy requires concurrent interventions that accommodate the physiological changes of pregnancy.[4,5] While we intend to focus on resuscitative cesarean delivery, details of cardiac arrest in pregnancy will be included in our discussion to contextualize the performance of this procedure. Most of the evidence regarding cesarean delivery during maternal cardiac arrest is limited to case reports and case series; high-quality prospective or randomized studies with control groups are lacking. As a result, clinical guidance in this area relies heavily on expert opinion, often extrapolated from the management of obstetric hemorrhage. We aim to explore the history and indications of cesarean delivery during maternal cardiac arrest, including pregnancy-specific resuscitation team interventions and the operative techniques guiding the performance of this infrequent but highly relevant life-saving procedure.

## Evolution of perimortem cesarean delivery

Historical records of cesarean delivery trace back to ancient times, particularly in ancient Rome and parts of the Far and Middle East. In 715 BC, Numa Pompilius, the second king of Rome, decreed via the "Lex Regia" that a fetus must be extracted from its dead mother before her burial, primarily for religious rites rather than as a life-saving procedure.[6–8] This practice, rooted in ceremonial traditions, persisted in various forms for centuries. It was not until 1305 that a French physician, Bernard of Gordon, attempted a postmortem cesarean delivery intending to rescue the fetus.[9]

Cesarean deliveries were not performed on living patients until the 1500s, marking the beginning of a gradual shift in goals toward saving both the mother and baby.[10] However, the procedure was associated with high mortality rates for both. It was not until 1827 that the first successful cesarean delivery in the United States was performed. John Richmond, a physician in Newtown, Ohio, was credited with delivering a Black woman via cesarean delivery after she had been in labor for more than 24 hours and experiencing eclamptic seizures. The abdominal wall was closed, and it is reported that the mother recovered within the month.[10] The introduction of intra-abdominal suturing, aseptic technique, and later antibiotics transformed cesarean delivery into a consistently survivable procedure. The advancement shifted its primary purpose from perimortem fetal rescue to a life-saving procedure for both mother and fetus.[10]

An intriguing paradox emerged as advancement in obstetric and cardiopulmonary resuscitation techniques progressed.[11] As Katz notes in his review of perimortem cesarean delivery, the shift of childbirth to hospital settings led to changes in the causes of maternal cardiac arrest, with acute conditions such as embolism becoming more recognized.[11] Postmortem cesarean deliveries were then performed primarily as attempts to save the fetus. In these cases of sudden maternal collapse, performing a postmortem cesarean delivery while continuing chest compressions sometimes resulted in successful maternal resuscitation. Terminology shifted from "postmortem" to "perimortem" cesarean delivery, as some patients, although critically unstable, were revived following uterine evacuation and ongoing chest compressions.[11]

When to initiate the resuscitative cesarean delivery can be a challenging aspect of maternal cardiac arrest resuscitation. The "4-minute rule," or the time in which a resuscitative cesarean delivery should be initiated, was more formally introduced in 1986, based on the understanding that maternal brain anoxia begins after 4 minutes of cardiac arrest.[12] Related to the physiological changes of pregnancy, Katz recognized that traditional cardiopulmonary resuscitation is ineffective in late pregnancy due to uterine compression on the great vessels and that there could be improved maternal and fetal outcomes if the patient is delivered in a timely fashion. Without early and effective cardiopulmonary resuscitation, anoxic brain injury is observed to start between 4 and 6 minutes,[13] and given the increased oxygen and metabolic demands of pregnancy, accelerated cellular death and maternal and fetal deterioration is expected to occur. There was also reported fetal benefit, noting that most of the surviving infants were delivered within the 5-minute timeframe. Following this landmark study, the American Heart Association incorporated perimortem cesarean delivery into maternal resuscitation guidelines in 1992.[6] Katz later published a case series of 38 patients, demonstrating that timely perimortem cesarean delivery, regardless of the patient's hemodynamic status, could improve maternal outcomes when combined with ongoing resuscitative efforts.[14] This was a groundbreaking concept, as cesarean delivery had historically been associated with considerable morbidity and mortality.

## Terminology

Using clear and consistent terminology in resuscitative obstetrics can help strengthen interdisciplinary team communication and improve effectiveness during emergency situations. Studies show that clearly defined terms reduce ambiguity, helping healthcare teams respond more effectively to rapidly evolving clinical situations.[15,16] This precise use of language is especially valuable in high-stress situations, where even minor miscommunications can result in delays that impact outcomes for both patient and child. A standardized vocabulary allows for seamless coordination among obstetricians, anesthesiologists, emergency physicians, and nursing staff.[17]

Terms like "Perimortem Cesarean Delivery," "Resuscitative Hysterotomy," and "Resuscitative Cesarean Delivery," although closely related, have nuanced differences that can impact clinical decisions. All these terms refer to a cesarean delivery performed during maternal cardiac arrest when there is no pulse, usually within 4 minutes, with the primary goal of resuscitating the maternal patient. However, the use of "perimortem" in the term perimortem cesarean delivery suggests the procedure is being done as a last-ditch effort to save

the fetus as the patient is dying.[18] While resuscitative hysterotomy and resuscitative cesarean delivery both contain the term "resuscitative," which reminds the team that this is an essential step in cardiopulmonary resuscitation for maternal cardiac arrest, the use of hysterotomy is only partially accurate, as the procedure not only involves entry into the uterus (ie, the definition of "hysterotomy") but also requires the evacuation of all its contents. Additionally, healthcare workers who do not work in obstetrics or gynecology may not be familiar with the term "hysterotomy," which may result in delays or errors in team performance during the cardiopulmonary response. Resuscitative cesarean delivery not only specifies that the maneuver is being done as one of the steps to achieve the return of spontaneous circulation, irrespective of gestational age or the number of fetuses, but contains the easily recognizable procedural terminology "cesarean delivery,"[18] which is a far more recognizable procedural term for healthcare workers on the resuscitation team who may not work in obstetric settings.

Understanding these distinctions ensures that healthcare providers act with clarity and shared intent in urgent situations. Protocols and guidelines based on well-defined terms enable consistent training and expectations, helping teams anticipate each other's actions and align quickly during emergencies. As the literature suggests, aligning terminology across healthcare settings can reduce response times and increase adherence to best practices, ultimately leading to improved maternal and neonatal outcomes.[19,20]

## Physiology, indications, and team planning for resuscitative cesarean delivery

The physiology underlying the decision to perform a resuscitative cesarean delivery is centered on the unique maternal and fetal adaptations during pregnancy. As pregnancy progresses, the gravid uterus exerts increasing pressure on the inferior vena cava, potentially compromising venous return to the heart, especially when the patient is in a supine position.[21,22] This pressure can decrease cardiac output and hinder effective circulation, which is critical during resuscitation efforts.[23,24] By removing the fetus and placenta, resuscitative cesarean delivery can relieve this compression, enhancing venous return and facilitating resuscitative efforts. This physiological effect is essential for maternal resuscitation and can help improve oxygen delivery. Additionally, the enlarging gravid uterus also compresses the aorta. While initial aortic compression may increase blood flow to vital organs, over time, aortic compression causes the heart to work harder, further worsening the oxygen deficit. Resuscitative delivery also produces an autotransfusion—return of autologous blood to the person's own circulation—originating from the uteroplacental unit that further enhances cardiac output with relief of aortocaval compression.[25]

The indications for resuscitative cesarean delivery are specific and time-sensitive, typically involving maternal cardiac arrest at a gestational age of 20 weeks or more. The "4-minute rule" is a well-established guideline suggesting that resuscitative cesarean delivery should be initiated within 4 minutes of cardiac arrest if the return of spontaneous circulation has not been achieved.[11] This short window is critical as maternal survival, particularly intact survival, has been shown to improve the closer the resuscitative cesarean delivery is done to the time of arrest, and because the fetus's neurological outcomes are highly dependent on timely delivery and oxygenation if fetal survival is possible.[18] Resuscitative cesarean delivery is indicated in cases where maternal arrest is refractory to initial resuscitative efforts, and while it may be performed to attempt to save both the patient and the fetus, its primary outcome is resuscitation of the patient. Given this, fetal monitoring should be deprioritized during the initial resuscitation of maternal cardiac arrest and is not a consideration in timing or initiation of resuscitative cesarean delivery. Recognizing the clear indications and having a strategy based on a resuscitation algorithm can help prevent delays that could compromise the life of the gravid patient or the neonate(s) (Figure 1).

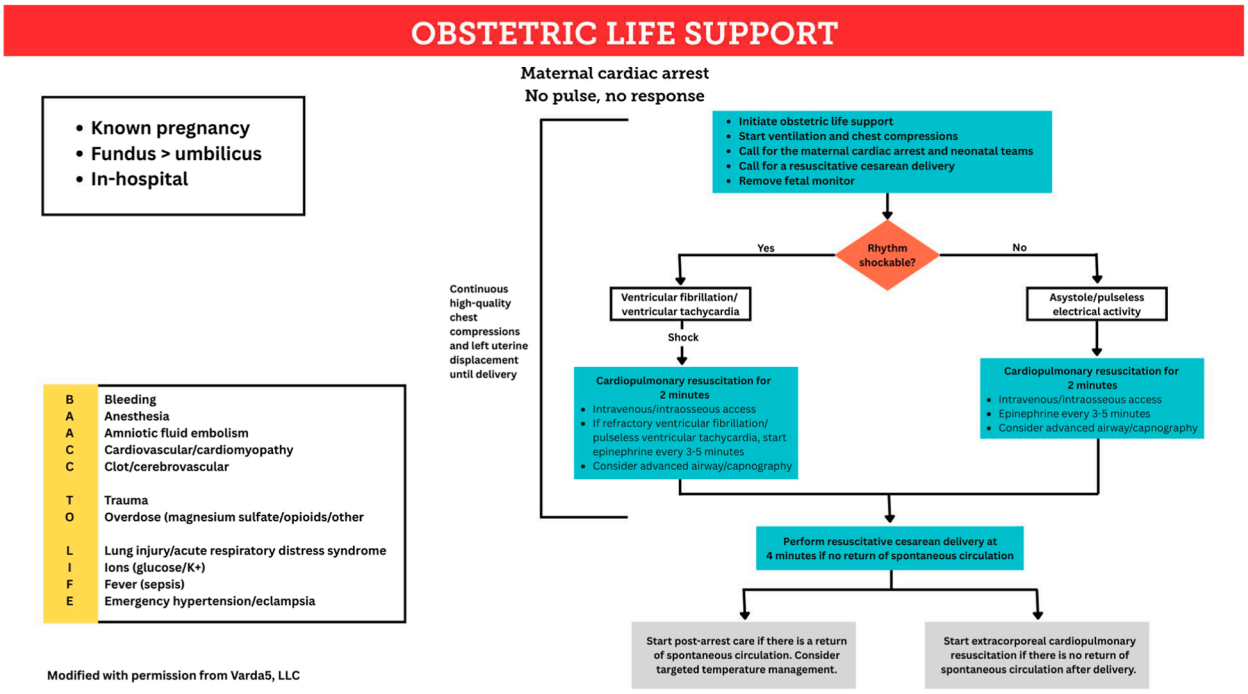
Effective team planning is essential when preparing to perform resuscitative cesarean delivery, as it is a high-stakes, interdisciplinary intervention. This procedure requires coordination among obstetricians, anesthesiologists, emergency physicians, and nursing staff, each of whom has a distinct role. Team planning involves clear communication, role assignments, and the availability of necessary equipment to ensure the rapid initiation of resuscitative cesarean delivery within the critical time frame. Simulation-based training can improve team efficiency, ensuring that each team member is familiar with the protocol and can act quickly in a real scenario.[4,26,27] The structured preparation helps reduce chaos, improves response times, and maximizes the chances of a positive outcome for both the patient and the fetus(es).

## Timing of resuscitative cesarean delivery

The timing of resuscitative cesarean delivery is one of the most critical factors influencing the outcome of both the patient and fetus in cases of maternal cardiac arrest. The generally accepted guideline, known as the "4-minute rule," recommends that resuscitative cesarean delivery should be initiated within 4 minutes of maternal cardiac arrest if the return of spontaneous circulation has not been achieved.[11] The goal is to deliver the fetus by the 5-minute mark to enhance the effectiveness of maternal resuscitation efforts and to minimize the risk of severe hypoxic brain injury in the fetus. This short time frame is based on evidence that maternal outcomes improve when resuscitative cesarean delivery is done as proximate to the time of maternal cardiac arrest, as well as irreversible neurological damage can begin within 4 to 5 minutes of oxygen deprivation in the fetus, making swift intervention crucial.[14,28,29]

However, there are certain circumstances where waiting for the 4-minute time from maternal cardiac arrest is less

**FIGURE 1**
**Obstetric life support maternal cardiac arrest algorithm (reproduced with permission from Varda5, LLC)**


OBSTETRIC LIFE SUPPORT
Maternal cardiac arrest
No pulse, no response
• Known pregnancy
• Fundus > umbilicus
• In-hospital
• Initiate obstetric life support
• Start ventilation and chest compressions
• Call for the maternal cardiac arrest and neonatal teams
• Call for a resuscitative cesarean delivery
• Remove fetal monitor
Rhythm shockable?
Yes
No
Ventricular fibrillation/ ventricular tachycardia
Shock
Asystole/pulseless electrical activity
Continuous high-quality chest compressions and left uterine displacement until delivery
Cardiopulmonary resuscitation for 2 minutes
• Intravenous/intraosseous access
• If refractory ventricular fibrillation/ pulseless ventricular tachycardia, start epinephrine every 3-5 minutes
• Consider advanced airway/capnography
Cardiopulmonary resuscitation for 2 minutes
• Intravenous/intraosseous access
• Epinephrine every 3-5 minutes
• Consider advanced airway/capnography
Perform resuscitative cesarean delivery at 4 minutes if no return of spontaneous circulation
Start post-arrest care if there is a return of spontaneous circulation. Consider targeted temperature management.
Start extracorporeal cardiopulmonary resuscitation if there is no return of spontaneous circulation after delivery.
B Bleeding
A Anesthesia
A Amniotic fluid embolism
C Cardiovascular/cardiomyopathy
C Clot/cerebrovascular
T Trauma
O Overdose (magnesium sulfate/opioids/other
L Lung injury/acute respiratory distress syndrome
I Ions (glucose/K+)
F Fever (sepsis)
E Emergency hypertension/eclampsia
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prudent and should be performed immediately after losing a pulse. For example, any patient at term (37+ weeks) should have a resuscitative cesarean delivery performed immediately if requiring basic life support and advanced cardiac life support interventions such as high-quality cardiopulmonary resuscitation to optimize maternal and fetal outcomes. Additionally, resuscitative cesarean delivery can be performed immediately with concurrent cardiopulmonary resuscitation after 20 weeks or uterine size equivalent if the fetus is not living or not expected to survive due to a life-limited fetal condition.[18] Finally, any patient who experiences an out-of-hospital maternal cardiac arrest without return of spontaneous circulation should have a resuscitative cesarean delivery immediately upon arrival to the emergency department as they have been pulseless ≥4 minutes.

In patients <20 weeks and in refractory cardiopulmonary resuscitation, defined as cardiac arrest that lasts more than 10 minutes of cardiopulmonary resuscitation or more than 3 defibrillation attempts, resuscitative cesarean delivery may be considered, as compression of the inferior vena cava has been reported as early as 15 weeks. At least one case report demonstrated return of spontaneous circulation after resuscitative cesarean delivery for refractory maternal cardiac arrest at 15 weeks.[30] A case series of 50 gravid patients who underwent magnetic resonance imaging in the supine positions demonstrates that even up to 36% of pregnant patients between 12+0 and 19+6 weeks have evidence of inferior vena cava compression; therefore, resuscitative cesarean delivery may also play a role in the resuscitation of patients <20 weeks (A. Shields, personal communication, January 15, 2025).

## Surgical considerations

There are several critical logistical considerations when performing a resuscitative cesarean delivery during maternal cardiac arrest. Traditionally, surgical procedures are conducted in the sterile environment of an operating room. However, in the case of a resuscitative cesarean delivery, the time spent transporting the patient represents a marked delay that can compromise outcomes for both patient and fetus. In cases of inpatient maternal cardiac arrest, resuscitative cesarean delivery should be performed at the location of arrest.[18,31] Studies have shown that even high-performing teams frequently fail to meet the "4-minute rule," and further delays caused by transporting the patient to the operating room do not provide any benefit. On the contrary, such delays often reduce the quality of chest compressions during resuscitation efforts.[25,32] Therefore, the recommended approach is to perform resuscitative cesarean delivery at the patient's bedside. To facilitate this, crash carts in labor and delivery units and any other units caring for pregnant patients should be equipped with a readily available scalpel. Once return of spontaneous circulation is achieved or the patient is stabilized, transfer to the operative room can be considered to complete the surgery under controlled conditions.

If a pregnant patient in maternal cardiac arrest is brought to the hospital from the prehospital setting, current recommendations advise performing the resuscitative cesarean delivery in the emergency department or primary receiving department. Time should not be wasted transporting the patient to the operating room or to labor and delivery unit before initiating the procedure.[32]

Ideally, an obstetrics-trained surgeon should perform the resuscitative cesarean delivery. In the event an obstetrician is not available, any credentialed provider in resuscitative cesarean delivery may perform the procedure. This could include general or trauma surgeons, emergency medicine physicians, or family medicine physicians. Noncredentialed providers are not recommended to perform a resuscitative cesarean delivery. In the absence of a qualified surgeon, high-quality cardiopulmonary resuscitation with continuous left uterine displacement should be maintained until a skilled surgeon arrives to perform the procedure.[33]

### Surgical technique

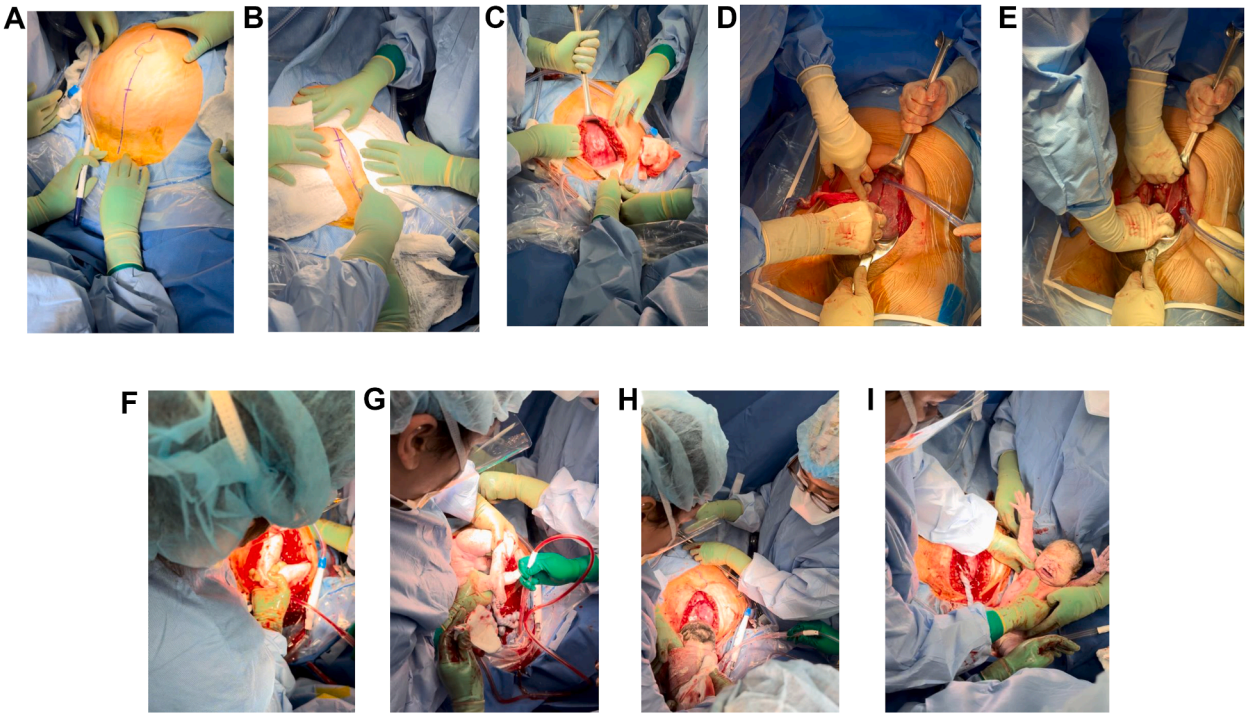
Although there is no standardized surgical approach for performing a resuscitative cesarean delivery, there are several critical considerations to ensure its effectiveness.[34] Once the decision to proceed with resuscitative cesarean delivery has been made, the primary goal is to evacuate the uterus within the first minute of the procedure (Figure 2). Entry is achieved using a #10-blade scalpel.

### Skin incision and abdominal entry for resuscitative cesarean delivery

When performing resuscitative cesarean delivery, the choice of incision should align with the operator's training and the clinical scenario. Obstetricians may prefer a Pfannenstiel incision due to familiarity with this approach. However, a vertical midline incision is generally recommended in most cases, especially when the surgeon is not obstetrically trained, due to its speed, versatility, and reduced risk of complications.

A vertical midline incision offers several advantages. It minimizes the risk of injuring the superficial epigastric vessels, a common concern with Pfannenstiel incisions, and avoids the need to vertically extend a horizontal incision, which could result in an "anchor" shape. Additionally, this approach lowers the risk of injuring the inferior epigastric arteries, which can occur with horizontal entry into the fascia. A low vertical incision starting just below the umbilicus is often ideal for resuscitative cesarean delivery, as it allows for easy extension in trauma scenarios, giving surgeons as much or as little additional access as needed. This incision type is

**FIGURE 2**
**Steps in resuscitative cesarean delivery (reproduced with permission from Varda5, LLC)**




**A,** *(Not recommended during resuscitative cesarean delivery)* Illustration of marking the abdomen to indicate the vertical skin incision site. **B,** Make a vertical skin incision from below the umbilicus to above the pubic symphysis. **C,** Retract tissues to expose the uterus. **D,** Incise the uterus vertically near or over the fundus. **E,** Enlarge the uterine incision by stretching with fingers. **F,** Locate and guide both fetal feet to the incision. **G,** Deliver the fetal feet up to the scapula. **H,** Complete delivery of the fetus. **I,** Handle the newborn carefully.

particularly advantageous in cases involving potential adhesive disease from prior abdominal surgeries, abdominal trauma requiring exploratory laparotomy, or direct access to the aorta for interventions such as cross-clamping in severe hemorrhage or trauma. It also facilitates access to the diaphragm if cardiac massage or other trauma-related procedures are necessary.

After making the skin incision, use the initial scalpel (a 10-blade scalpel) to cut down to the fascia. Once the fascia is exposed, open it sharply with the same scalpel, following the same plane as the skin incision, and then stretch it open manually. At this stage, the rectus muscles will become visible. The peritoneum is most easily accessed through the linea alba by blunt dissection with fingertips or sharp dissection with Kelly clamps (if available). Once the peritoneum is entered, manually stretch the incision and, if available, insert a bladder blade. At this point, the uterus will be visible.

*Uterine incision*

The most definitive approach to entering the uterus during a resuscitative cesarean delivery involves making a vertical incision, as opposed to a horizontal incision, on the anterior uterine wall for efficient evacuation of the uterus.[18] This allows for easier extension in the event that more space is required to evacuate the uterus.

For obstetricians, the choice of incision may vary based on the clinical scenario and the suspected gestational age of the fetus. In some cases, a horizontal lower uterine segment incision may be appropriate and can be employed at the discretion of the operating provider. The decision should consider factors such as uterine anatomy, gestational age, adhesive disease, or other surgical considerations.

*Other surgical considerations*

Up to this stage of the surgery, the procedure is typically bloodless. Surgeons should anticipate the release of amniotic fluid upon entering the uterine cavity. Accumulation of fluid around the patient can pose a risk of electrical conduction during cardiac defibrillation, potentially endangering the patient, providers, or equipment. Rescuers should place extra towels or blankets around the patient's torso and upper body to absorb fluid and minimize the risk of the patient lying in pooled amniotic fluid—particularly if defibrillation is anticipated during resuscitative efforts.

After evacuating the uterus, a return of spontaneous circulation is likely, and the surgeon should prepare for potential bleeding. The uterine incision can be quickly repaired by suturing in a running fashion using 0-braided or monofilament suture or temporarily closing it with penetrating towel clamps. The abdomen can be packed as needed until definitive wound management is addressed.

Following return of spontaneous circulation, considerable hemorrhage may occur, accompanied by ongoing resuscitation challenges due to reperfusion and/or coagulopathy. A multifaceted approach should be employed, including:

- Mechanical uterine compression techniques;
- Pharmacological uterotonics, avoiding administration of oxytocin as an intravenous bolus as this may cause rearrest;[35]
- Activation and use of massive transfusion protocols; and
- Pelvic vessel embolization.

Resuscitative endovascular balloon occlusion of the aorta, although commonly used for trauma and placenta accreta spectrum, may also effectively manage hemorrhage.[36] In severe cases, peripartum hysterectomy may provide definitive control.

The use of extracorporeal life support can further complicate management by introducing risks of both bleeding and clotting, requiring meticulous attention to hemostasis.

## Wound management considerations after resuscitative cesarean delivery

Wound management following a resuscitative cesarean delivery is uniquely challenging due to the urgency and circumstances of the procedure. Immediate management focuses on rapidly closing the incision to stabilize the patient, particularly if the return of spontaneous circulation is achieved after uterine evacuation. In these emergencies, surgical preparation is often suboptimal, and wound closure may initially involve a quick approximation of the hysterotomy to control bleeding and minimize the risk of infection. Once the patient is stabilized, a more detailed evaluation and revision of the wound may be necessary, ideally in a controlled operating room environment.

After return of spontaneous circulation and initial wound closure, ongoing care prioritizes infection prevention. Resuscitative cesarean delivery wounds are highly susceptible to infection because of the emergent nature of the procedure, limited sterile conditions, and potential contamination. Broad-spectrum antibiotics are typically administered as prophylaxis, particularly given the suboptimal conditions where the wound is often closed. Wound dressings should be managed carefully, with a sterile technique used during changes to monitor for signs of infection, such as redness, swelling, warmth, or drainage. If the initial wound closure is incomplete or compromised, negative pressure wound therapy can promote healing.

Long-term wound care involves monitoring for proper healing, addressing complications, and potentially revising the wound closure if necessary. If the initial closure was temporary, a definitive reclosure may be planned once the patient is stable, emphasizing achieving both functional and cosmetic outcomes. Supporting wound healing through proper nutrition, glycemic control, and close follow-up in a postoperative or intensive care setting is critical. Postcardiac arrest patients are particularly vulnerable to delayed healing due to compromised perfusion and other critical illness-related factors.

## Summary

Performing surgery on a hemodynamically unstable patient may seem counterintuitive; however, resuscitative cesarean delivery is a critical intervention in cases of maternal cardiac arrest. Pregnancy introduces marked

physiological changes, including compression of the inferior vena cava and aorta by the gravid uterus, which can severely compromise venous return, cardiac output, and systemic perfusion. Resuscitative cesarean delivery provides immediate aortocaval decompression, results in an autotransfusion, and ultimately improves hemodynamic stability. By removing the mechanical obstruction caused by the uterus and improving cardiac output, resuscitative cesarean delivery optimizes the conditions for effective chest compressions, enhances the efficacy of resuscitation efforts, and increases the likelihood of restoring maternal circulation.

In addition to its benefits for maternal resuscitation, resuscitative cesarean delivery improves the chances of fetal survival by delivering the baby promptly. During maternal cardiac arrest, uteroplacental blood flow ceases, depriving the fetus of oxygen. Timely delivery of the fetus—typically within 5 minutes of cardiac arrest onset—not only reduces fetal hypoxia but also relieves the physiological burden on the patient. This dual benefit underscores the importance of resuscitative cesarean delivery as a lifesaving measure for both the maternal patient and the fetus, even under circumstances where surgical intervention might initially seem high-risk. When performed efficiently, resuscitative cesarean delivery transforms an otherwise dire situation into one with substantially improved outcomes for both the patient and the fetus(es).

As evidence continues to evolve, future work should explore variations in resuscitative cesarean delivery technique based on maternal body habitus and specific clinical scenarios, as well as the psychological impact on clinicians who perform this rare yet emotionally demanding intervention.

The following steps are performed rapidly during cardiopulmonary resuscitation to deliver the fetus via resuscitative cesarean delivery using gloved hands.

**Prepare for the incision**

- Expose the maternal abdomen.
- Call out your intention to start a resuscitative cesarean delivery so the person performing left uterine displacement can stop and move away from the patient.
- The maternal abdomen is marked to illustrate where to make the vertical skin incision [a]. During cardiopulmonary resuscitation, marking the abdomen is not necessary and would only delay the resuscitative maneuver.
- If additional space is needed for delivery or uterine repair, extend the incision to the right of the umbilicus as illustrated.

**Perform the abdominal incision**

- Make a vertical incision from just below the umbilicus to just above the pubic symphysis [b].
- Quickly incise all abdominal wall layers and sharply open the fascia in the same plane as the skin incision using a 10-blade scalpel.
- Manually stretch the fascia by hooking the fingers of each hand under it and pulling superiorly and inferiorly.
- The uterus is now exposed [c].

**Open the uterus**

- Make a vertical uterine incision, ideally close to or over the fundus, to avoid bladder injury [d].
- Stretch the uterine incision bluntly by hooking fingers under the edges and pulling superiorly and inferiorly [e].
- If the uterine wall is thick (as in preterm gestations, particularly $<30-32$ weeks), extend the incision over the uterine fundus using Mayo or bandage scissors. Protect the fetus during this step by placing 2 fingers inside the uterus to lift the wall away from the fetus before cutting.

**Delivering the cephalic (head down) fetus**

- Confirm the fetal head's position and alignment within the uterus.
- Ensure the uterine incision is appropriately sized to allow safe delivery of the head.
- Elevate the head through the incision, avoiding excessive traction or force.
- Apply fundal pressure (if needed) to guide the head through the uterine incision.
- Maintain support of the neck and shoulders as the head emerges to prevent hyperextension.
- Adjust the position of the fetus if necessary to align with the incision for smooth delivery.
- Deliver the anterior shoulder first by gently guiding it under the uterine incision.
- Rotate and deliver the posterior shoulder, followed by the rest of the body in a smooth, controlled motion.
- Avoid excessive force to reduce the risk of injury to both the fetus and the uterine incision.
- Use appropriate instruments, such as a vacuum extractor, only if clinically indicated.

**Delivering the breech (buttock down) fetus**

- Locate both fetal feet and guide them to the incision [f].
- Gently pull the fetal feet to deliver the fetus up to the scapula [g].
- Rotate the fetus so the back is facing upward (if not already in this position).
- Deliver the arms.
    - Run fingers along one humerus to the elbow and sweep the arm across the chest.
    - Rotate the fetus 180° and repeat to deliver the other arm.
- If the head does not deliver spontaneously:
    - Perform the Mauriceau-Smellie-Veit maneuver.
    - Use one hand to flex the head by gently applying pressure to the maxilla (avoiding the eyes and inside the mouth).
    - Curve the fingers of the other hand over the shoulders to guide and support the head.
    - The fetus is now delivered and handled with care [h,i].

### Postdelivery steps

- Clamp and cut the umbilical cord and then hand the neonate to the awaiting team.
- Insert a hand into the uterus to extract the remaining cord and placenta. Ensure complete placental removal by inspecting its fetal surface for uniformity.

### Close the uterine incision

- Close the incision by suturing in running fashion using 0-braided or monofilament suture or temporarily close it with penetrating towel clamps.

### Address the abdominal wound

- Pack the abdomen as needed until definitive management of the resuscitative cesarean delivery wound is completed. ■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